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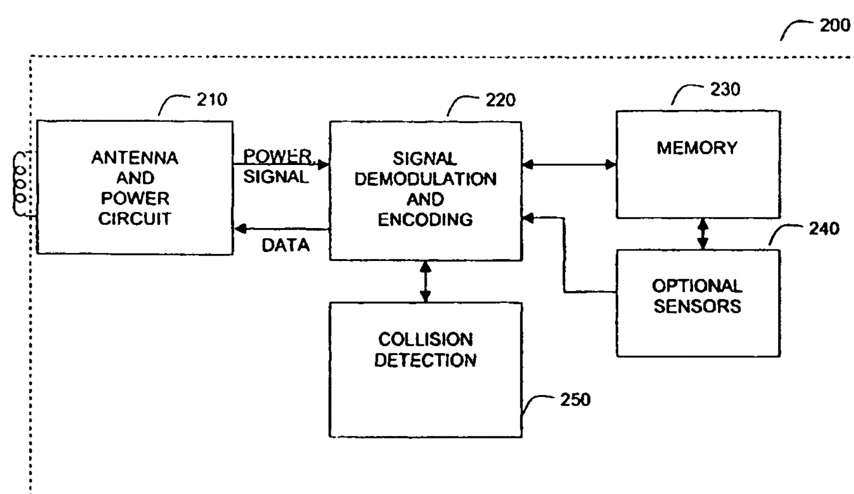
(54) Title: METHOD AND APPARATUS FOR DETUNING A RESONANT CIRCUIT OF A REMOTELY POWERED DEVICE



(57) Abstract: A method and apparatus are provided for selectively de-tuning a resonant circuit (410, 420) of a remotely powered device (400). The resonant circuit is tuned to a carrier frequency corresponding to an interrogation signal from an interrogator which powers the remotely powered device. Selective de-tuning of the resonant circuit may become necessary when the interrogation signal from the interrogator device is too powerful for the monitoring device resulting in an induced voltage that exceeds a predetermined threshold. When operative, selective de-tuning reduces the efficiency of coupling power from the interrogation signal into the monitoring device. As a result, less power is coupled into the device, which reduces unwanted heating, limits voltage applied to the power terminal of the device to a safe, desirable level, prevents damage to the device and allows it to operate effectively in temperature sensing applications.

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METHOD AND APPARATUS FOR DETUNING A RESONANT CIRCUIT OF A REMOTELY POWERED DEVICE

FIELD OF THE INVENTION:

The present invention relates generally to remotely powered devices and, more particularly, to a remotely powered transmitting device that includes a resonant circuit for coupling radio frequency (RF) power into the device and a de-tune circuit for regulating the extent of the coupling.

BACKGROUND OF THE INVENTION:

As electronic components continue to become smaller, less expensive and more power efficient, their uses in different applications are increasing. An example of an increasingly popular use is in monitoring applications, where inexpensive electronic components may be used to facilitate monitoring inventory levels, temperature levels or other conditions. In the case of inventory monitoring, components called radio frequency identification devices (RFIDs) may be used.

A RFID device stores in memory identification codes, such as an item number, style number or serial number, for an item to which it is physically attached. RFID devices are generally not powered by a battery. Rather, RFID devices are typically remotely powered by an interrogation signal transmitted from an interrogation device. The interrogation signal is transmitted at a predetermined carrier frequency. The RFID device includes a resonant circuit having a resonant frequency at the carrier frequency of the interrogation device to ensure maximum power transfer to the RFID. In operation, all RFID devices within range of an interrogation device turn on in response to being powered by the interrogation signal. Each

RFID device stores and uses energy from the interrogation signal to read its memory and transmit all or some of its stored data back to the interrogation device. The interrogation device reads this data and typically provides the data to an inventory system. In this manner, inventory may be efficiently and remotely monitored and tracked using a remote monitoring system including RFID devices.

Other remotely powered devices may be used to monitor the condition of an apparatus, environment or process. For example, a remotely powered device may include a temperature sensor and may, in response to an interrogation signal, transmit a temperature reading or many stored temperature readings back to the interrogation device.

In general, remotely powered monitoring devices are powered by rectifying the radio frequency (RF) carrier signal of the interrogation signal. The monitoring device generally includes a resonant circuit tuned to the carrier signal to ensure maximum power transfer from the interrogation signal to the monitoring device. The monitoring device uses the rectified signal to charge a capacitor which powers the device for a short interval of time during which transmission of the stored data from the monitoring device to the interrogator may occur.

A problem of remotely powered monitoring devices, including RFID devices, is that if the interrogator is too close to the monitoring device, or if the interrogation signal is otherwise too strong, the monitoring device can overheat and become damaged. Damage occurs because an excess of power is transferred to the device which results in excessive induced voltage or excessive power dissipation in the monitoring device.

To alleviate problems associated with excessive voltage being coupled into the device, zener diodes have been used to clamp the voltage coupled into the monitoring device by a resonant circuit. This is effective at limiting the voltage, however, heat is generated as a result of

power being dissipated across the zener diode(s). This heat may either damage the monitoring device or may render the monitoring device ineffective for certain applications, such as monitoring temperature, because the device temperature may not reflect environmental conditions of interest.

There is a need for a new technique for coupling power from an interrogation signal into a monitoring device which does not overheat when the interrogation signal is too strong and/or too close to the monitoring device. There is a further need for a technique which uses a resonant circuit apparatus to transmit and receive data. There is still a further need for a technique which minimizes voltage induced and power dissipation at the device when the interrogation devices is too strong and/or too close to the monitoring device.

SUMMARY OF THE INVENTION:

According to embodiments of the present invention, a method and apparatus are provided for selectively de-tuning a resonant circuit of a remotely powered device. The resonant circuit is tuned to a carrier frequency corresponding to an interrogation signal from an interrogator which powers the remotely powered device. Selective de-tuning of the resonant circuit may become necessary when the interrogation signal from the interrogator device is too powerful for the monitoring device resulting in an induced voltage that exceeds a predetermined threshold. When operative, selective de-tuning reduces the efficiency of coupling power from the interrogation signal into the monitoring device. As a result, less power is coupled into the device, which reduces unwanted heating, limits voltage applied to the power terminal of the device to a safe, desirable level, prevents damage to the device and allows it to operate effectively in temperature sensing applications.

According to embodiments of the present invention, a method and apparatus are provided for selectively de-tuning a resonant circuit of a remotely powered device when voltage induced on the device exceeds a predetermined threshold. Selective de-tuning may become necessary when the interrogation signal from the interrogator device is too powerful for the monitoring device. When operative, selective de-tuning reduces the efficiency of coupling power from the interrogation signal to the monitoring device. As a result, less power is coupled into the device, which reduces unwanted heating and limits voltage applied to the power terminal of the device to a safe, desirable level. This prevents damage to the device and allows it to operate effectively in temperature sensing applications.

According to one embodiment of the present invention, a circuit limits power dissipation on a remotely powered device. The circuit includes a resonant circuit having parallel capacitor and coil elements, a rectifier, a voltage divide network and a de-tune circuit. The resonant circuit is tuned to a carrier frequency of an interrogation signal, which provides the remote power to the remotely powered device, from an interrogator. The coil element includes a shunt portion that may be selectively shunted. The rectifier is coupled between the resonant circuit and at least one of power and ground voltages. The voltage divide network is coupled between the power and ground voltages and derives a voltage there between. The de-tune circuit is controllably coupled to the derived voltage and shunts the shunt portion when the power rises above a predetermined threshold.

The voltage divide network may include a diode network, a resistor network, a network of active devices or combinations thereof. The de-tune circuit may be a transistor or a network of transistors. In addition, an output device may be coupled to a data signal and to the shunt

portion of the coil. The output device may selectively shunt the shunt portion of the coil based on the data signal to transmit an amplitude modulated data signal to an interrogator device.

According to another embodiment of the invention, a method of providing a de-tune circuit for a remotely powered device includes: providing a resonant circuit having a capacitor and a coil; providing a shunt connection for shunting a portion of the coil; providing a rectifier for rectifying a voltage induced in the resonant circuit; and connecting a device across the shunt portion of the coil for selectively shunting the coil when the rectified voltage is too high.

The method may further include connecting an output device across the shunt portion of the coil for modulating the resonant circuit based on a data signal. The de-tune circuit may be part of a remote monitoring device which may also include a memory or a sensor from which the data signal is derived.

BRIEF DESCRIPTION OF THE FIGURES:

The above described features and advantages of the present invention will be more fully appreciated with reference to the detailed description and figures, in which:

Fig. 1 depicts a functional diagram of an interrogation device transmitting an interrogation signal in the presence of a plurality of monitoring devices.

Fig. 2 depicts a functional block diagram of a monitoring device.

Fig. 3 depicts an antenna circuit having zener diodes for clamping induced voltage according to the prior art.

Fig. 4 depicts a circuit diagram illustrating an antenna circuit having a de-tuning portion within the monitoring device according to an embodiment of the present invention.

Figs. 5A and 5B depict a voltage divider and rectifier respectively.

Fig. 6 depicts a method of selectively de-tuning a resonant circuit according to an embodiment of the present invention.

DETAILED DESCRIPTION:

Fig. 1 depicts a system 100 for remote monitoring according to an embodiment of the present invention. The system 100 includes an interrogation device 110 and a plurality of monitoring devices 120, 130 and 140. The monitoring devices are generally attached to physical items of interest. For example, the monitoring devices may be attached to assets, inventory, a motor, a wall, a light bulb or any other item that one desires to monitor. The monitoring device includes memory and/or a sensor for storing or collection information about the item to which it is attached. In one embodiment of the invention, the monitoring devices are radio frequency identification devices (RFIDs) which store in memory identification codes, such as an item number, style number or serial number, for an item to which it is physically attached. In other embodiments of the invention, the monitoring device may further include a sensor for detecting the temperature or other conditions of the item that it monitors.

The monitoring devices 120-140 are not powered by a battery. Rather, the monitoring devices are remotely powered by an interrogation signal transmitted from the interrogation device 110. The interrogation signal is transmitted at a predetermined carrier frequency. The carrier frequency may be any convenient frequency depending on the application. Each monitoring device includes a resonant circuit (shown in Figs. 2 - 4) having a resonant frequency at the carrier frequency of the interrogation device to insure maximum power transfer to the monitoring device.

In operation, all monitoring devices within range of an interrogator 110 turn on in response to being powered by the interrogation signal 150. Each RFID device stores and uses energy from the interrogation signal 150 to read its memory and transmit all or some of its stored data 160 (and/or sensor reading) back to the interrogator 110. The interrogator 110 receives the data 160 and may provide the data to another system for tracking and/or taking action based on the data. In the case of RFID devices attached to inventory, the interrogator 110 may provide the received data 160 to an inventory system which tracks inventory levels and takes various actions based on the levels.

Fig. 2 depicts a functional block diagram of a monitoring device. Referring to Fig. 2, the monitoring device 200 includes a resonant circuit and input/output stage 210, a signal demodulation and encoding block 220, a memory 230, optional sensors 240, and a collision detection unit 250. The resonant circuit and input/output stage 210 is used to generate a power voltage (VDD) for the monitoring device by coupling the interrogation signal 150 from the interrogator 110 into a resonant circuit and rectifying the signal. It also may alter elements of the resonant circuit to de-tune the resonant circuit when the interrogator is too close according to embodiments of the present invention. It further includes an output device which receives a data signal from the signal demodulation and encoding block 220 and modulates the resonant frequency of the resonant circuit based on the data signal. By modulating the resonant frequency of the resonant circuit of the monitoring device, corresponding voltage fluctuations are induced in the resonant circuit of the interrogator 110. The voltage fluctuations induced in the interrogator comprise an amplitude modulated data signal from the monitoring device from which the underlying data is recovered. Similarly data may be sent from the interrogator to the

monitoring device by modulating the interrogation signal 160. Any carrier wave based modulation scheme is contemplated for data transfer.

The signal demodulation and encoding unit 220 includes control logic to reset the chip upon receiving a power signal, to derive and distribute clock signals, to transmit a data signal and to demodulate the interrogation signal to recover data.

The memory stores data which may be programmed using a programming device and external pins of the monitoring device. The memory may also include data that is derived from a sensor or received from the interrogation signal. The memory may include memory arrays and registers. In the case of RFID devices, the memory includes a non-volatile portion into which tag data is stored. The memory may provide the data to the encoding unit 220 in response to a read monitoring device command received from the interrogator 110.

The optional sensor 240 may measure temperature, vibrations or any other convenient condition. Data from the sensor 240 may be stored in the memory 230 or provided to the encoding unit 220 in response to a read monitoring device command received from the interrogator 110. The collision detection unit 250 is coupled to the signal demodulation and encoding unit. It detects whether other monitoring devices are active and influences when the data from the memory or the sensor is encoded and applied to the output stage 210 for transmission to the interrogator 110. The collision detection unit 250 acts to cause the monitoring device to transmit its data signal in a time slot that is not likely to be occupied by another monitoring device.

A problem with remotely powered devices such as the monitoring devices 120-140 shown in Fig. 1 is that if a particular monitoring device is too close to the interrogator 110, the monitoring device may couple in too much power and thereby damage the monitoring device.

For example, referring to Fig. 1, monitoring device 130 may be too close to the interrogator, monitoring device 140 may be within range but without being too close and device 120 may be outside of the range and therefore inoperative. In order to prevent too high a voltage or too much power from being coupled to a monitoring device, various solutions have been implemented.

Fig. 3 depicts a resonant circuit and input/output stage 300 that has been implemented to limit voltage induced in the resonant circuit of the monitoring device. Voltage limitation is desirable to prevent damage to other circuits on a monitoring device on which the resonant circuit and input/output stage 300 is implemented. Referring to Fig. 3, the circuit 300 includes a resonant circuit comprising an inductor 310 and a capacitor 320 connected in parallel between power and ground. In parallel with the resonant circuit are zener diodes 340 and 350 which prevents voltage across the resonant circuit from rising significantly beyond the sum of the reverse bias zener diode voltage and the forward biased zener diode voltage. As an unwanted side effect, when the voltage across the zener diodes 340 and 350 exceed the sum of the reverse bias zener diode voltage and the forward biased zener diode, the zener diodes conduct current and shunts the resonant circuit. This causes power to be dissipated through the zener diodes and unwanted heating of the device. In fact, if the interrogation signal is sufficiently strong and/or close, the power dissipated across the zener diodes can cause melting and permanent damage to the monitoring device.

Fig. 4 depicts a resonant circuit and input output stage 400 according to an embodiment of the present invention which avoids the above problems. Referring to Fig. 4, the circuit 400 includes a resonant circuit comprising a capacitor 410 and a coil element (or elements) 420. Both the capacitor 410 and the coil 420 may be (and are preferably) external to the monitoring device. The monitoring device may include, for example, external pins A, B and C. Pins A and

C may be used to secure respective ends of the capacitor 410 and coil 420. External pin B may be used to connect to a portion of the coil element that is selectively shunted. Alternatively, two coils may be implemented, one coil between pins A and B and another coil between pins B and C. For both cases, the coil 420 is described herein as a single coil with a shunt portion. The coil 420 and capacitor 410 are chosen to set a resonant frequency for the resonant circuit at the resonant frequency of the carrier signal for the corresponding interrogator.

The transistors 430 and 440 have their sources connected to ground (terminal C) and their drains connected to pin B. As such, the transistors 430 and 440 are operative to selectively shunt a shunt portion of the coil 420 of the resonant circuit. When the monitoring device is in a transmitting mode, transistor 430 receives a data signal from derived from data in the memory 230 or sensors 240. The transistor 440 is used to selectively de-tune the resonant circuit when the device power level rises above a predetermined threshold. As an alternative to a single transistor 440, a network of transistors may be used to selectively de-tune the resonant circuit consistent with ordinary principles of circuit design.

The rectifier 470 is coupled between the resonant circuit and one or both of the power and ground signals on the monitoring device. The capacitor 460 is coupled between the device power and ground. It acts as a voltage terminal and an energy storage element to store energy coupled into the monitoring device from the interrogation signal and to apply the power to other circuits on the monitoring device for a short duration at the power voltage.

The voltage divider 450 is coupled between the power voltage signal and the ground signal. It is used to derive a voltage which is connected to the gate of the transistor 440. The derived voltage from the voltage divider turns the transistor 440 into a conducting state when the voltage of the power signal rises above a predetermined threshold. When the transistor 440 turns

on, it tends to shunt the shunt portion of the coil 420 and adds resistance to the coil 420. The resistance may be chosen for a particular damping characteristic. This shunting changes the resonant frequency of the coil and capacitor 410 and therefore de-tunes the resonant circuit so that it is less efficient at coupling power into the monitoring device. De-tuning also reduces the induced voltage across the resonant circuit and therefore prevents the voltage between power and ground on the device from reaching damaging levels. It also avoids problems of power dissipation that occur in the circuit shown in Fig. 3 because de-tuning according to the circuit of Fig. 4 prevents unwanted power from entering the monitoring device. The voltage divider network and the inductive value of the shunt portion of the coil 420 should be chosen to induce a voltage on the device power terminal above the minimum operating voltage of the monitoring device for foreseeable operating conditions of the device.

It is apparent from Fig. 4 that the output transistor 430 and the de-tuning transistor 440 may selectively shunt the same shunt portion of the same coil 420. This is an efficient design and obviates the need for an abundance of external coil and capacitor elements.

Fig. 5A depicts an implementation of a voltage divider that may be used according to one embodiment of the present invention. Alternatively, any voltage divider may be implemented including resistor divide networks, diode divide networks, networks that use active devices such as transistors and combinations thereof.

Fig. 5B depicts an embodiment of a rectifier 470. Referring to Fig. 5B, the rectifier 470 is shown to include two diodes 500 and 510. The diode 510 has its cathode connected to the resonant circuit and to the anode of the diode 500. Referring to Fig. 5B, the diode 500 is depicted as having its cathode connected to the power voltage. This network is a voltage doubler and deposits positive charge on the capacitor 460 relative to the ground terminal, while

preventing the resonant circuit from removing the positive charge on the capacitor. Any other rectifier may be used to charge the capacitor 460 to a positive or negative level relative to ground in order to supply power to the monitoring device.

Fig. 6 depicts a method of providing a de-tune circuit for a monitoring device according to an embodiment of the present invention. Referring to Fig. 6, the method includes providing a resonant circuit having a capacitor and a coil in step 600, providing a shunt connection for shunting a portion of the coil in step 610 and providing a rectifier for rectifying a voltage induced in the resonant circuit in step 620. During operation, the voltage induced in the resonant circuit will be a voltage signal at the carrier frequency of the interrogation signal. In step 630, a transistor is connected to the rectified voltage signal and across the shunt portion of the coil for selectively shunting the coil when the rectified voltage is too high. In step 640, an output device is coupled across the shunt portion of the coil to modulate the resonant circuit based on a data signal. This results in inducing an amplitude modulated data signal being induced in the interrogator device.

While specific embodiments of the invention have been shown and described, it will be understood by those having ordinary skill in the art that changes may be made to those embodiments without departing from the spirit and scope of the invention. For example, while the shunt portion of the coil of the resonant circuit has been shown to be shunted out when the induced voltage exceeds a predetermined threshold, an alternative is to add the shunt portion to the coil when the voltage exceeds the predetermined threshold.

CLAIMS:

What is claimed is:

1. An apparatus for limiting power dissipation on a remotely powered device, comprising:

   a resonant circuit having parallel capacitor and coil elements, the coil element including a shunt portion that may be selectively shunted;

   a rectifier coupled between the resonant circuit and at least one of power and ground voltages;

   a voltage divide network, coupled between the power and ground voltages; and

   a de-tune circuit controllably coupled to a voltage derived from the voltage divide network, the de-tune circuit shunting the shunt portion when the power rises above a predetermined threshold.

2. The apparatus according to claim 1, wherein the voltage divide network comprises at least one diode connected transistor.

3. The apparatus according to claim 1, wherein the voltage divide network further comprises at least one resistor.

4. The apparatus according to claim 3, wherein the voltage divide network further comprises at least one diode connected transistor.

5. The apparatus according to claim 1, further comprising a series capacitor coupled between the resonant circuit and the rectifier.

6. The apparatus according to claim 1, wherein the rectifier comprises:

a first diode coupled in parallel with the resonant circuit and having an anode coupled to a ground potential; and

a second diode coupled in series with the resonant circuit and having a cathode coupled to a power voltage for the device.

7. The apparatus according to claim 1, wherein the de-tune circuit is a transistor.

8. The apparatus according to claim 1, wherein the de-tune circuit comprises a plurality of transistors.

9. The apparatus according to claim 1, further comprising:

an output device coupled to a data signal and to the shunt portion, the output device selectively shunting the shunt portion based on the data signal.

10. A method of providing a de-tune circuit for a remotely powered device, comprising:

providing a resonant circuit having a capacitor and a coil;

providing a shunt connection for shunting a portion of the coil;

providing a rectifier for rectifying a voltage induced in the resonant circuit; and

connecting a device across the shunt portion of the coil for selectively shunting the coil when the rectified voltage is too high.

11. The method according to claim 10, further comprising:

connecting an output device across the shunt portion of the coil for modulating the resonant circuit based on a data signal.

12. The method according to claim 11, wherein the de-tune circuit is provided on a monitoring device.

13. The method according to claim 12, wherein the monitoring device includes a memory and wherein the data signal is generated based on data in the memory.

14. The method according to claim 12, wherein the monitoring device includes a sensor and wherein the data signal is generated based on data from the sensor.

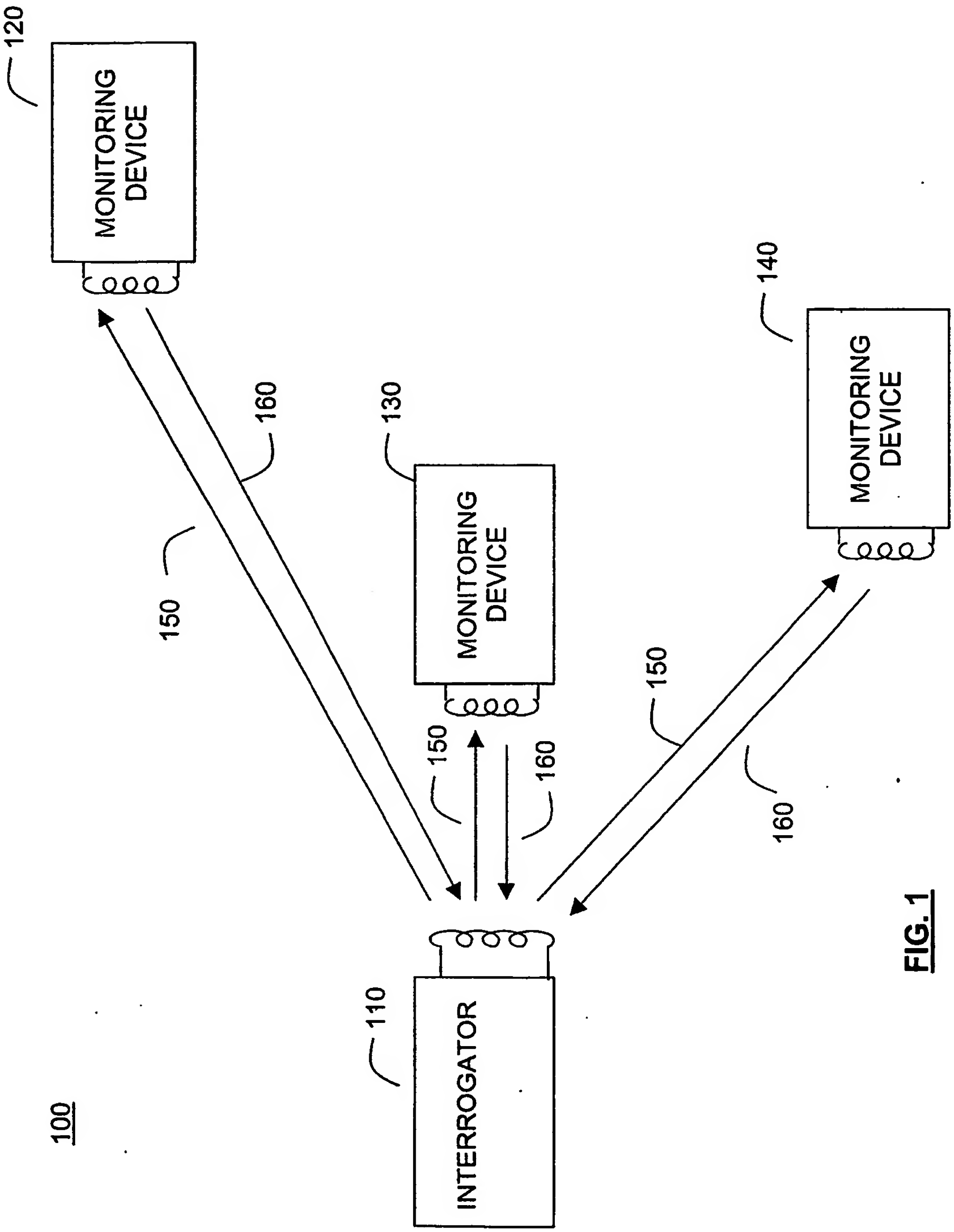

100
110
INTERROGATOR
120
MONITORING DEVICE
130
MONITORING DEVICE
140
MONITORING DEVICE
150
160
150
160
150
160

FIG. 1

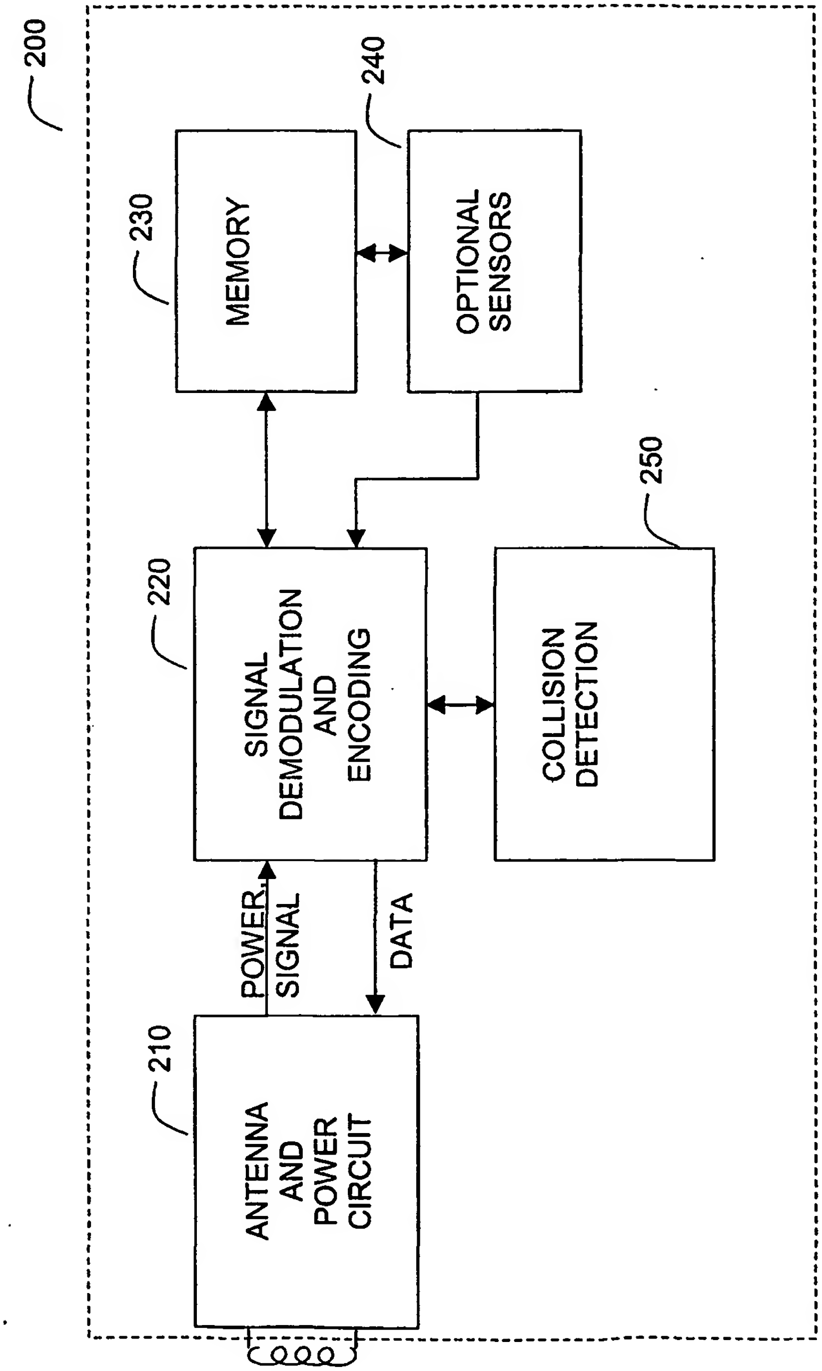

200
240
230
MEMORY
OPTIONAL SENSORS
250
220
SIGNAL DEMODULATION AND ENCODING
COLLISION DETECTION
POWER
SIGNAL
DATA
210
ANTENNA AND POWER CIRCUIT

FIG. 2

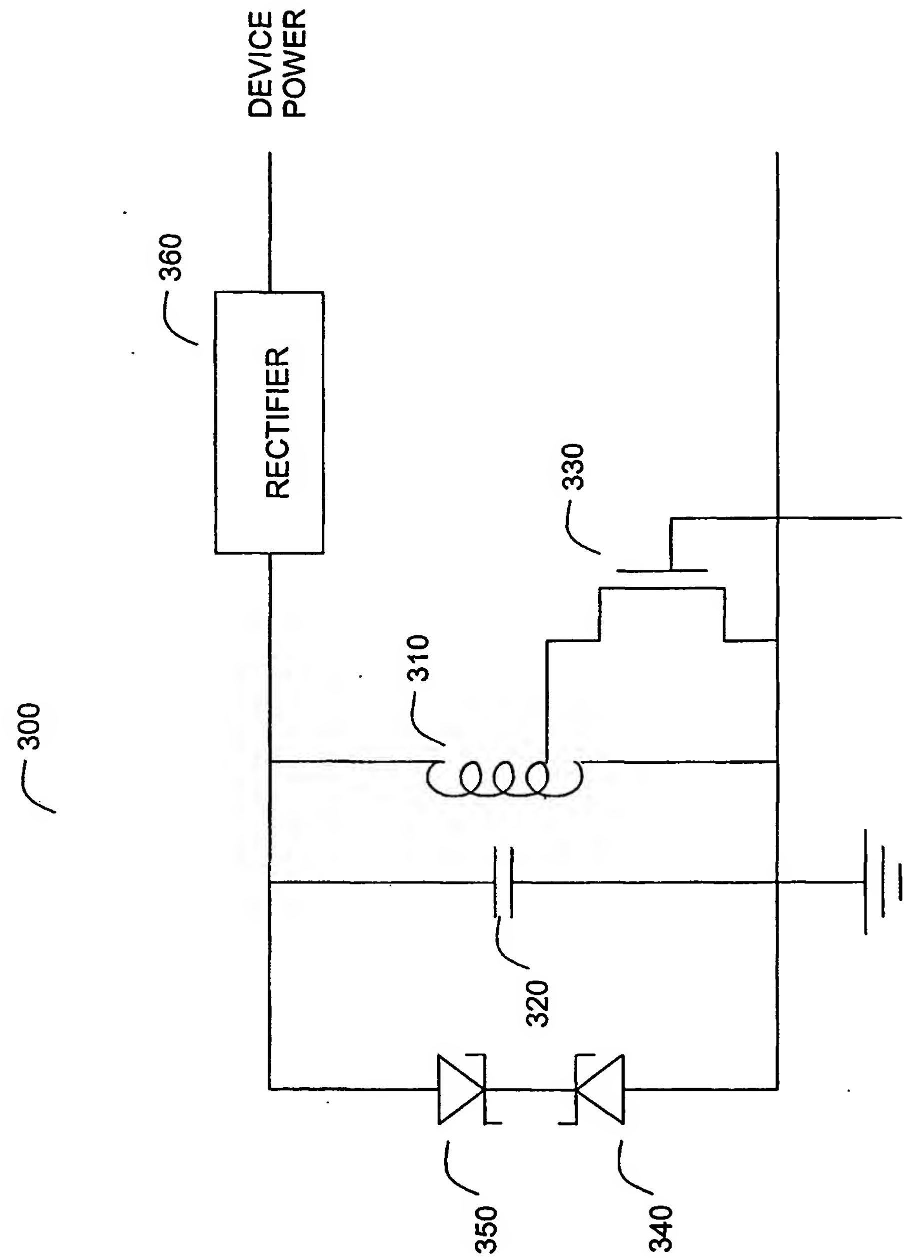


FIG. 3

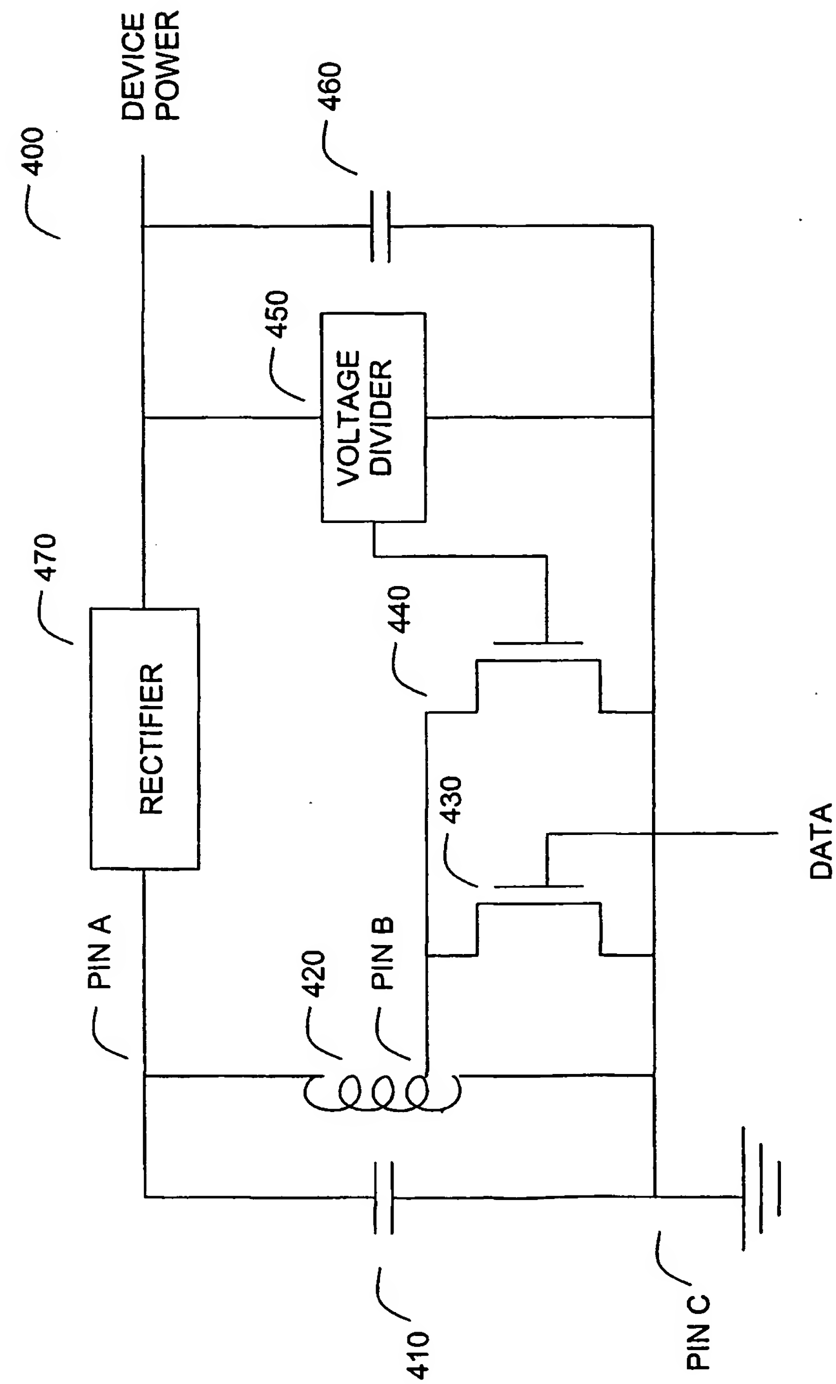
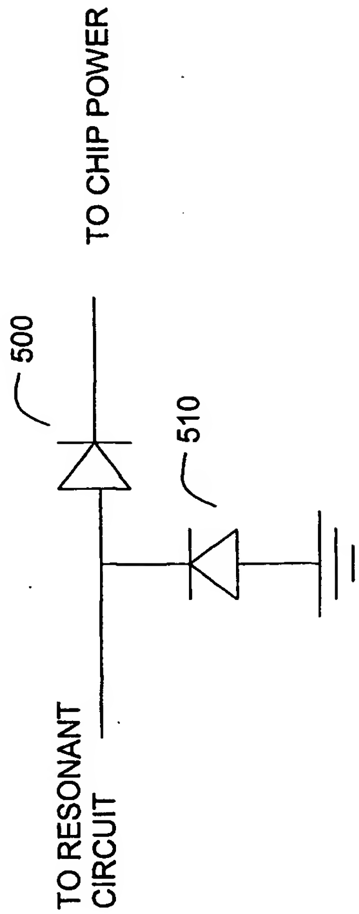
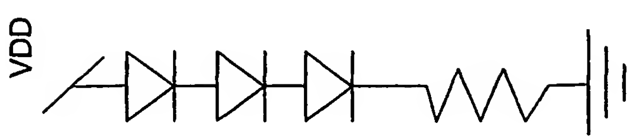

DEVICE POWER
400
460
450
VOLTAGE DIVIDER
470
RECTIFIER
440
430
DATA
PIN A
420
PIN B
410
PIN C

FIG. 4



RECTIFIER

FIG. 5B



VOLTAGE DIVIDER

FIG. 5A

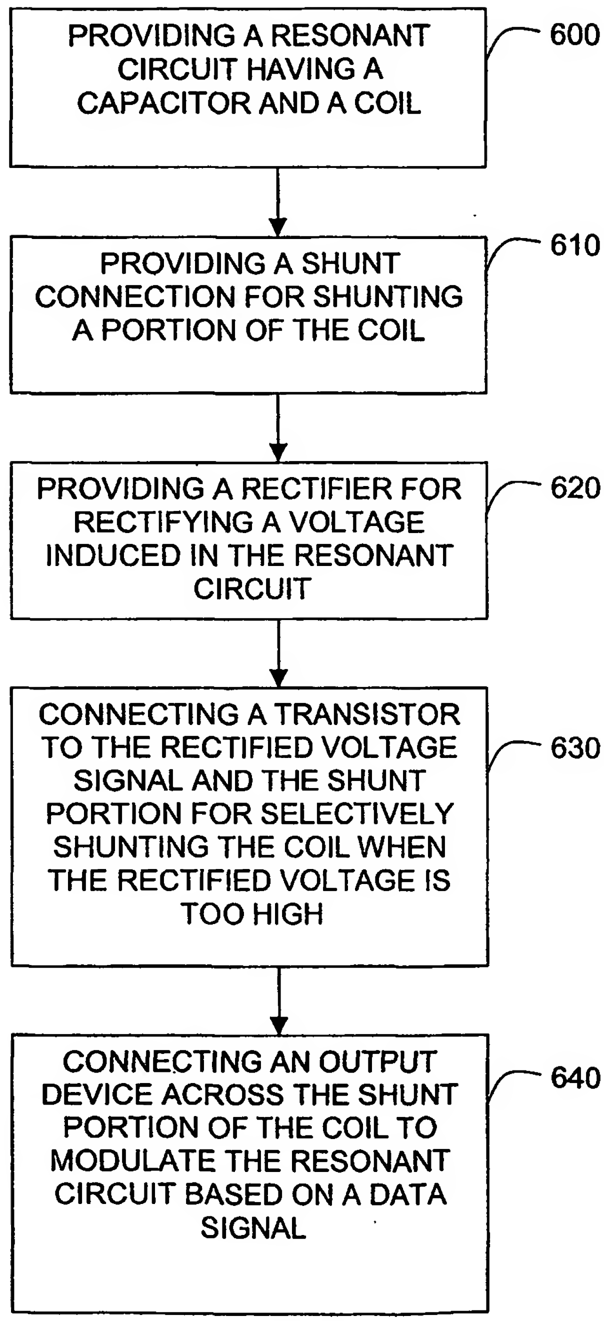

PROVIDING A RESONANT CIRCUIT HAVING A CAPACITOR AND A COIL
600
PROVIDING A SHUNT CONNECTION FOR SHUNTING A PORTION OF THE COIL
610
PROVIDING A RECTIFIER FOR RECTIFYING A VOLTAGE INDUCED IN THE RESONANT CIRCUIT
620
CONNECTING A TRANSISTOR TO THE RECTIFIED VOLTAGE SIGNAL AND THE SHUNT PORTION FOR SELECTIVELY SHUNTING THE COIL WHEN THE RECTIFIED VOLTAGE IS TOO HIGH
630
CONNECTING AN OUTPUT DEVICE ACROSS THE SHUNT PORTION OF THE COIL TO MODULATE THE RESONANT CIRCUIT BASED ON A DATA SIGNAL
640

FIG. 6

INTERNATIONAL SEARCH REPORT

Inte[rnatio]nal Application No
PCT/US 01/30022

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K19/07

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 442 390 A (TEXAS INSTRUMENTS DEUTSCHLAND) 21 August 1991 (1991-08-21) column 3, line 2 -column 4, line 17; figure 1	1-14
X	FR 2 782 209 A (INNOVATRON ELECTRONIQUE) 11 February 2000 (2000-02-11) page 2, last paragraph -page 4, paragraph 5 page 6, paragraph 4 -page 7, paragraph 3 page 8, paragraph 2 - paragraph 6; figures 1-3	1-14
X	GB 2 321 726 A (MOTOROLA INC) 5 August 1998 (1998-08-05) abstract page 6, line 7 -page 7, line 28; figures 2A,3	1-14

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 March 2002	15/03/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Gysen, L

Int[illegible]nal Application No
PCT/US 01/30022

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 301 127 A (TEXAS INSTRUMENTS DEUTSCHLAND) 1 February 1989 (1989-02-01) column 13, line 57 -column 14, line 23; figure 2	1,9-14
A	WO 98 26370 A (INNOVATRON IND SA ;WEHOWSKI FREDERIC (FR)) 18 June 1998 (1998-06-18) page 9, line 16 - line 30; figure 1	1,9-14

INTERNATIONAL SEARCH REPORT

rmation on patent family members

Inte nal Application No
PCT/US 01/30022

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